

**REMARKS****Amendments to the Claims**

Claims 23-25, 29, 30, 32-34 and 44-47 are pending in this application. Claims 23 and 44 are amended. Support for the amendments can be found throughout the specification as originally filed, for example, at paragraphs 17, 35, 44, 49, 59, Table 1, and claims as originally filed. No new matter has been added. Claims 1-22, 26-28, 31 and 35-43 are canceled.

The Examiner has rejected claims 23-25, 29, 30, 32-34 and 44-47.

**Previous Rejections**

The Examiner has withdrawn the rejection of claim 23 as being anticipated by Jochum et al. (5,100,929) in response to the amendment of claim 23 to recite that the initiator is selected from camphorquinone and 2,2-dimethoxy-2-phenyl acetophenone.

The Examiner states that she has fully considered Applicant's arguments filed 07-15-2009 but did not find them persuasive.

Applicants earlier argued that Jochum et al. teach that using a combination of camphorquinone and acyl phosphine oxide results in a "smeary layer". This argument is found to be unpersuasive by the Examiner, who provides the following reasons: What Jochum et al. teach, in column 2, lines 13-19, is that when a combination of camphorquinone and tertiary amine or a combination of acylphosphine oxide and tertiary amines is used the compositions cured with visible light have a pronounced layer of smear. Thus, Jochum et al. teach against using a combination of camphorquinone and tertiary amine or a combination of acylphosphine oxide and tertiary amines, not against a combination of camphorquinone and acylphosphine oxide visible light initiators. Furthermore, the Examiner notes that the comprising language in the instant claim does not exclude additional initiating components, i.e. the acylphosphine compound taught by Jochum et al., from the composition.

Applicants earlier argued that the instantly claimed compositions are distinguished from those taught by Jochum et al. because oxygen inhibition is not seen in the photopolymerized

compositions of the instant application. However, the Examiner states that Applicants have not provided any comparative evidence to support this argument. The Examiner alleges that the polymerizable compositions disclosed by Jochum et al. comprise the same polymerizable components as are set forth in instant claim 23. The choice of photo initiator would not have been expected to have resulted in different properties being obtained after photopolymerization of the thiol-functional monomer and the vinyl-functional monomers, in the absence of evidence to the contrary. The reason given is that it is the polymerizable materials that would be expected to determine the properties of the product. Jochum et al. teach that a "smeary layer" results when camphorquinone is used with a tertiary amine in UV curable compositions and that the problem does not occur with the thiol-ene compositions comprising at least 10 % by weight thiol and at least 10% by weight "ene" components.

With respect to the combination of teachings of Jochum et al. and Rheinberger et al., Applicants earlier argued that the dental material taught by Rheinberger et al. comprises a silicic acid condensate of norbornene or thiol. This argument was not found persuasive by the Examiner because Jochum et al. are relied upon for teaching polymerizable thiol-ene dental composition representative of the instantly claimed compositions. Rheinberger et al. are relied upon for teaching alternative initiators that are useful for polymerizing thiol-ene functional compositions.

#### **Claim Rejections Under 35 U.S.C. § 103**

Claims 23, 24, 25, 29, 30, 32-34 and 44 have been rejected under 35 U.S.C. §103(a) as being obvious over Jochum et al. (5,100,929). The Examiner argues that Jochum et al. disclose dental compositions comprising thiol-enes and a photoinitiator and filler (column 2, line 33, to column 3, line 19). Jochum et al. teach that compositions containing at least 10% by weight polythiol compound, at least 10 % by weight poly-ene compound and an acylphosphine compound as photoinitiator provide a cured product free of a smeary layer. Fillers are taught from column 6, line 64, to column 7, line 15. The Examiner states that Jochum et al. do not disclose using 2,2-dimethoxy-2-phenyl acetophenone as initiator.

It would have been obvious, according to the Examiner, to one skilled in the art at the time of the invention to employ camphorquinone, instead of or in combination with the

acylphosphine oxide, as a visible light initiator in the thiol-ene compositions disclosed by Jochum et al. The reason given is that Jochum et al. teach that camphorquinone and acyl phosphine oxides are known initiators responsive to visible light for polymerizing dental compositions. It is noted by the Examiner that the comprising language in the instant claim does not exclude additional initiating components, i.e. the acylphosphine compound taught by Jochum et al., from the instantly claimed composition. The Examiner alleges it would further have been obvious to one skilled in the art at the time of the invention to omit using a tertiary amine in combination with camphorquinone or acylphosphine oxide in order to avoid a smeary layer resulting from incomplete cure, as taught by Jochum et al.

With respect to claims 24 and 25, the Examiner states that Jochum et al. does not specifically disclose the recited percentage ranges of thiol functional groups. However, since Jochum et al. teach that the compositions contain at least 10% by weight polythiol compound, the instantly recited ranges are considered to be within the disclosure of Jochum et al., in the absence of evidence to the contrary. The Examiner continues that with respect to claims 29, 30 and 32-34, Jochum et al. do not mention the specified properties recited. However, since the polymerizable compositions disclosed by Jochum et al. comprise the same components as are set forth in instant claim 23, the instantly claimed properties are expected to be inherent to the prior art polymerized products, in the absence of evidence to the contrary. The choice of photo initiator allegedly would not have been expected to have resulted in different properties being obtained after photopolymerization of the thiol-functional monomer and the vinyl-functional monomers, in the absence of evidence to the contrary. The reason given by the Examiner is that it is the polymerizable materials that would be expected to determine the properties of the product.

Applicants respectfully traverse the rejection of the claims under 35 U.S.C. §103(a) over Jochum et al.; however, in the interest of advancing prosecution, independent claim 23 has been amended to address the Examiner's concerns. Claim 23 has been amended to add three limitations. Firstly, the claim has been amended such that the claimed polymerizable material contains no additional initiators. This is supported by the specification in that each example of polymerizable material in the instant specification contains either camphorquinone or DPPA with no additional initiators present. Secondly, the claim has been amended such that upon

exposure to light, the material cures without oxygen inhibition. Support can be found at paragraphs 17 and 49 and FIG. 2. Thirdly, the claim has been amended such that after polymerization the material exhibits a flexural strength of greater than 65 Mega Pascals. Support can be found in the claims as originally filed, and Table 1. Jochum et al. will be discussed below with respect to current claim 23. The Examiner is reminded that all pending claims are dependent on claim 23.

Jochum et al. teach specifically:

The subject of the invention is photopolymerizable dental compositions which are curable with visible light and which apart from the usual auxiliary substances and additives contain polymerizable monomers of the group of the poly-thiol compounds each having at least two thiol groups and polymerizable monomers of the group of the poly-ene compounds each having at least two ethylenically unsaturated groups and at least one photoinitiator, which are characterized in that the compositions contain respectively related to the sum of all the polymerizable monomers

- (a) at least 10% by weight of one or more of the polythiol compounds,
- (b) at least 10% by weight of one or more of the poly-ene compounds and
- (c) as photoinitiator 0.01-5% by weight of at least one acyl phosphine compound of the general formula I



wherein

Col. 2, lines 33-58.

Further: "The compositions according to the invention can be surprisingly cured without formation of a smeary layer with visible light of a wavelength > 400 nm." Col. 3, lines 23-25.

The Examiner has admitted that Jochum et al. do not teach the use of DPPA as a photoinitiator; therefore the following arguments are focused on what was taught by Jochum et al. insofar as the use of camphorquinone as a photoinitiator is concerned.

Jochum et al. discuss that it was generally known that avoidance of the smeary layer in known photopolymerizable compositions was difficult. Col. 1, line 15 to Col. 2, line 32.

To avoid the smeary layer caused by oxygen inhibition in photopolymerizable compositions a whole series of counter measures have already been proposed: A summary will be found in the article by George F. Vesley "Mechanisms of the Photodecomposition of Initiators" in the Journal of Radiation Curing, January 1986, pages 9 and 10. Apart from the technically very complicated proposal of carrying out the curing under a protective gas atmosphere, as a rule it is proposed that high initiator concentrations be used or so-called "oxygen interceptors" be added to the polymerizable compositions. Suitable "oxygen interceptors" are, for example, tertiary amines and certain furans. This enables an appreciable reduction of the smeary layer to be achieved but only when curing with very high-energy light of small wavelength (<400 nm).

Col. 1, lines 48-63.

Jochum later discuss what was known in the prior art with respect to use of camphorquinone as a photoinitiator in a single paragraph:

So far, all the attempts to transfer the steps described above contributing to a reduction of the smeary layer in UV-curing compositions to the field of compositions which can be cured with visible light (>400 nm) were unsuccessful. For instance, with combinations of photoinitiators responsive to visible light, for example campher quinone and acyl phosphine oxides, with tertiary amines photopolymerizable compositions are obtained which, although they can be cured with visible light, after the curing due to oxygen inhibition have a pronounced layer of smear (cf. DE-A-3,443,221). For this reason, in the field of dental materials relatively complicated methods are employed to prevent the formation of smear. Thus, it has been proposed that the curing of dental veneer materials be carried out in a liquid bath (DE-A-3,316,591) or the curing effected under vacuum (DE-A-3,001,616).

The invention is therefore based on the problem of providing novel compositions which can be cured with visible light without formation of a smeary layer and can be used in particular as dental compositions.

This problem is solved by the preparation of the dental compositions according to the invention.

Col. 2, lines 9-32.

Thus, Jochum et al. teach specifically that an acyl phosphine initiator must be employed in the disclosed compositions in order to avoid a smeary layer caused by oxygen inhibition when cured with visible light.

Therefore, when read in context, it would not be obvious in light of Jochum et al. to substitute another photoinitiator, much less camphorquinone which had been already been specifically taught as a photoinitiator associated with formation of a smeary layer, even when in the presence of a tertiary amine, a known "oxygen interceptor".

The instant specification discloses and enables use of the photoinitiators of current claim 23, camphorquinone and DPPA, for example, in paragraph 35; and does not disclose any composition with an acyl phosphine photoinitiator, or even any other additional initiator. However, the Examiner has expressed concern that the comprising language in the instant claim 23 does not exclude additional initiating components, i.e. the acylphosphine compound taught by Jochum et al. Therefore, strictly to satisfy the Examiner and advance prosecution, claim 23 has been amended to exclude additional initiators. Since claim 23 has been amended, the arguments also apply to dependent claims 24, 25, 29, 30, 32-34 and 44.

The Examiner requests data as to the lack of smeary layer formation due to oxygen inhibition in the formulations of the instant specification. Both statements and data showing lack of oxygen inhibition can be found in the original specification, in the abstract, and at paragraphs 17, 36, 49, and FIG. 2. It was generally known that oxygen has the ability to interfere with polymerization, as discussed by Jochum et al. It should be noted that no data is disclosed by Jochum et al. to show lack of smeary layer due to oxygen inhibition, merely the statement that the compositions according to the invention can be surprisingly cured without formation of a smeary layer with visible light.

In light of the above discussion and amendments to the sole independent claim 23, therefore also claims 24, 25, 29, 30, 32-34 and 44 dependent thereupon, reconsideration of the rejections are respectfully requested.

Claims 23, 24, 25, 29, 30, 32-34 and 44-47 have been rejected under 35 U.S.C. 103(a) as allegedly obvious over Jochum et al. (5,100,929) in view of Rheinberger et al. (5,889,132).

According to the Examiner, Jochum et al. disclose dental compositions comprising thiol-enes and a photoinitiator and filler wherein the compositions contain at least 10% by weight polythiol compound (column 2, line 33, to column 3, line 19). Jochum et al. teach that camphorquinone and acyl phosphine oxides are known as initiators responsive to visible light that produce a pronounced layer of smear in UV curing compositions and that this disadvantage is overcome by the disclosed compositions (column 2, lines 9-26). Fillers are taught from column 6, line 64, to column 7, line 15. Jochum et al. teach that camphorquinone and acyl phosphine oxides are known as initiators responsive to visible light for polymerizing dental compositions.

The Examiner states that Rheinberger et al. disclose thiol-ene dental compositions and photoinitiators therefor, including camphorquinone, acyl phosphine oxides and 2,2-dimethoxy-2-phenylacetophenone (column 28, lines 39-50); and with respect to claims 45-46, Rheinberger et al. teach that the alpha-diketones, such as camphorquinone, are preferably used with an amine reducing agent (column 28, lines 39-50, and Examples 7 and 11).

The Examiner argues it would have been obvious to one skilled in the art at the time of the invention to substitute camphorquinone for the acyl phosphine oxide photo initiator in the compositions disclosed by Jochum et al. Jochum et al. allegedly provide motivation by teaching that camphorquinone, as well as acylphosphine oxides, is well known for visible initiation of polymerization of dental compositions. Rheinberger et al. allegedly specifically teach that camphorquinone or acylphosphine oxides are suitable photoinitiators for thiol-ene dental compositions. The Examiner concludes that one skilled in the art at the time of the invention would have been motivated by a reasonable expectation of successfully photoinitiating polymerization of the thiol-ene dental compositions taught by Jochum et al. using camphorquinone as photo initiator, as taught by Rheinberger et al. in analogous dental compositions.

With respect to claims 45-46, the Examiner alleges it would have been obvious to one skilled in the art at the time of the invention to employ an amine reducing agent with a camphorquinone initiator. The reason given is that Rheinberger et al. teach that the alpha-diketones, such as camphorquinone, are preferably used with an amine reducing agent. The

Examine argues that one skilled in the art at the time of the invention would have been motivated by a reasonable expectation of curing the composition although possibly producing a smear layer as taught by Jochum et al.

With respect to claim 47, the Examiner believes it would have been obvious to one skilled in the art at the time of the invention to substitute or include 2,2-dimethoxy-2-phenylacetophenone for or with an acylphosphine oxide initiator in the compositions disclosed by Jochum et al. The reason given is that each of Jochum et al. and Rheinberger et al. teach polymerization of thiol-ene compositions and initiators therefor. Jochum et al. teach that acylphosphine oxides and camphorquinone are suitable initiators for thiol-enes, while Rheinberger et al. teach that 2,2-dimethoxy phenylacetophenone is also a suitable initiator for thiol-ene compositions. According to the Examiner, one skilled in the art at the time of the invention would have been motivated by a reasonable expectation of would have been motivated by a reasonable expectation that the thiol-ene compositions taught by Jochum et al. would be effectively cured using 2,2-dimethoxy phenylacetophenone as initiator.

Applicants respectfully traverse the rejection. Arguments with respect to Jochum et al. are presented above. Nonetheless, claim 23 has been amended such that the polymer of the claimed composition exhibits a flexural strength of greater than 65 Mega Pascals after polymerization. The amendment is supported throughout the disclosure, in Table 1, paragraphs 51 and 52, and in original claim 43.

Rheinberger et al., U.S. Pat. No. 5,889,132, teach a dental material comprising a silicic acid condensate of a hydrolysable and polymerizable norbornene silane or a silicic acid condensate of a hydrolysable and polymerizable mercaptosilane together with a reactant for a thiol-ene polymerization. Col. 1, lines 4-8.

Rheinberger et al. teach the inclusion of the silicic acid condensate in thiol-ene polymerizations results in high mechanical strength and hardness.



[57]

## ABSTRACT

A dental material is described which is characterized by a content of silicic acid condensates of norbornene or mercapto silanes, and which, after thiol-ene polymerisation with suitable reactants, shows only slight polymerisation shrinkage and produces polymerisates with high mechanical strength.

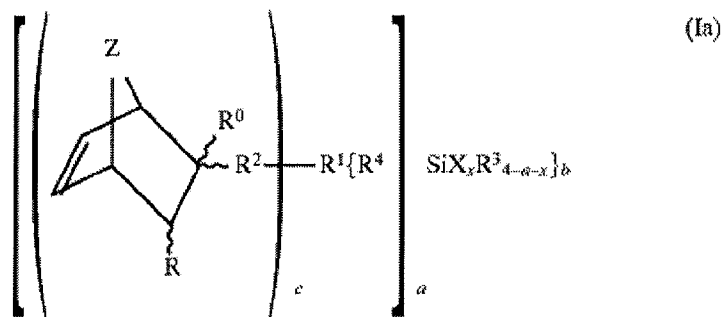
Rheinberger et al. further teach that with conventional thiol-ene polymerization systems only soft materials can be obtained.

A relatively low polymerisation shrinkage sometimes also occurs during the polyaddition of thiols to C—C unsaturated compounds, which is known from US-A-2 347 182. In this special type of polymerisation, which is also called ene-thiol or thiol-ene polymerisation, linear or crosslinked polysulphides with monosulphur form in the main chain. However, the obtained polysulphides have glass transition temperatures which are generally below or in the region of room temperature (cf. A. F. Jacobine et al. "Radiation curing of polymeric material", Editor: C. E. Hoyle et al., ACS-Symp. Ser. 417, (1990) 160 and cited there A. F. Jacobine et al. in J. Appl. Polym. Sci. 45, (1992) 471). Consequently, only soft materials with elastic or viscoelastic properties can be obtained with the conventional thiol-ene polymerisation systems.

Col. 2, lines 16-30

Therefore, Rheinberger et al. teach the thiol-ene compositions must comprise a silicic acid condensate in order to achieve appropriate mechanical strength. Although Rheinberger et al. disclose a number of photoinitiators, at least one silicic acid condensate must be included in the compositions to provide appropriate strength. According to Rheinberger et al.:

The dental material according to the invention comprises  
(a) at least one silicic acid condensate of a hydrolysable  
and polymerisable norbornene silane of general formula (Ia)



...

or

(b) at least one silicic acid condensate of a hydrolysable  
and polymerisable mercaptosilane of general formula  
(Ib)



Col. 2, line 41 to Col. 3, line 33.

In a first argument, Applicants find that the instant claimed photopolymerizable dental restorative materials, e.g. claim 23, are not prima facie obvious over Jochum et al. in view of Rheinberger et al. One of skill in the art at the time of filing would not combine the disclosure of Jochum et al. with the photoinitiators of Rheinberger et al, since Rheinberger et al. teach that a silicic acid condensate must be present in order to provide appropriate strength for dental materials. An example of appropriate hardness can be found in Rheinberger et al. In Example 11, Rheinberger et al. disclose a dental cement composition comprising a filler and a silicic acid condensate resin of Example 8 which exhibits flexural strength of 89 MPa and E-modulus of 5.5 GPa. See Col. 35, lines 35-60.

In an alternative argument, Applicants find that the claimed photopolymerizable dental restorative materials have unexpected properties in light of Jochum et al. in view of Rheinberger et al. Neither the instant specification, nor the instant claims, disclose or claim a composition

comprising a silicic acid condensate; yet unexpectedly the claimed materials have a flexural strength appropriate for dental materials. The instant filled materials exhibit a flexural strength and modulus of about the same or better than that of Rheinberger et al. Examples of flexural strength and modulus of the instant invention are shown in instant Table 1 from paragraph 52, which is reproduced below.

TABLE 1

Flexural strength test results for filled and unfilled PETMP/TATATO and Bis-GMA/TEGDMA. Both resin systems contain 0.3 wt % CQ and 0.8 wt % EDAB as visible light initiator. For filled systems, 60 wt % silanized quartz filler (mean particle size of 5 $\mu$ m) was used. All samples were cured with 580 mW/cm <sup>2</sup> visible light for 30 s on each side (n = 5).			
System	Flexural Strength (MPa)	Flexural Modulus (GPa)	Strain at Break (%)
PETMP/TATATO (Mol 3:4)	71.4 $\pm$ 2.7	1.6 $\pm$ 0.3	11.7 $\pm$ 0.9
PETMP/TATATO/Filler	112.0 $\pm$ 8.0	5.4 $\pm$ 0.7	3.9 $\pm$ 0.8
BisGMA/TEGDMA (Mass 7:3)	93.2 $\pm$ 8.3	2.6 $\pm$ 0.1	7.1 $\pm$ 2.4
BisGMA/TEGDMA/Filler	125.8 $\pm$ 7.3	7.5 $\pm$ 0.5	2.1 $\pm$ 0.3

Therefore, amended claim 23, and pending claims dependent thereupon are not obvious over Jochum et al. in light of Rheinberger et al. In light of the amendments and arguments, the Examiner is respectfully requested to reconsider the rejections.

It is believed that the amendments place the claims in condition for allowance. The foregoing amendments are made solely to expedite prosecution of the application and are not intended to limit the scope of the invention. Further, the amendments to the claims are made without prejudice to the pending or now canceled claims or to any subject matter pursued in a related application. Applicants reserve the right to prosecute any canceled subject matter at a later time or in a later filed divisional, continuation, or continuation-in-part application.

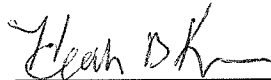
The foregoing is submitted as a complete response to the Office action identified above. Applicants respectfully submit that the present application is in condition for allowance and solicit a notice to the effect. If the Examiner believes a telephone conference would advance the

prosecution of this application, the Examiner is invited to telephone the undersigned at the below-listed telephone number.

It is believed that no fees are due with this submission. However, the Commissioner is hereby authorized to charge any deficiencies or credit any overpayment with respect to this patent application to deposit account number 13-2725.

Respectfully submitted,

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